CONTROL SYSTEMS IN OUR DAILY LIFE

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Abstract: This paper presents development and applications of Control Systems (CS). Several characteristics of CS can be linked to human behavior. CS can "think" in the sense that they can replace to some extent, human operation. CS can distinguish between open-loop and closed-loop CS and it is a concept or principle that seems to fundamental in nature and not necessarily peculiar to engineering. In human social and political organizations, for example, a leader remains the leader only as long as she is successful in realizing the desires of the group. CS theory can be discussed from four viewpoints as: an intellectual discipline within science and the philosophy of science, a part of engineering, with industrial applications and Social Systems (SS) of the present and the future. In global communication, developed countries and developing countries should build several attractive and sound symbiosis bridges, to prevent loss of universe balances. CS applications have social impacts not only in developed countries but also in developing countries. A new work force strategy without denying the existing of CS is established by retooling the work forces, thus the challenges of social impacts could be answers wisely and would be bright opportunities to improve human standards of living.

Keywords: CS, SS, social impacts, human standards of living.

1. INTRODUCTION

Control System (CS) is used to control position, velocity, and acceleration is very common in industrial and military applications. They have been given the special name of servomechanisms. With all their many advantages, **CS** in advertently act as an oscillator. Through proper design, however, all the advantages of **CS** can be utilized without having an unstable system.

Several characteristics of **CS** can be linked to human behavior. **CS** can "think" in the sense that they can replace to some extent, human operation. **CS** can distinguish between open-loop and closed-loop **CS** and it is a concept or principle that seems to fundamental in nature and not necessarily peculiar to engineering. In human social and political organizations, for example, a leader remains the leader only as long as she is successful in realizing the desires of the group. **CS** theory can be discussed from four viewpoints as: an intellectual discipline within science and the philosophy of science, a part of engineering, with industrial applications and social problems of the present and the future. In global communication, developed countries and developing countries should build several attractive and sound symbiosis bridges, to prevent loss of universe balances. **CS** applications have social impacts not only in developed countries but also in developing countries.

2. HUMAN CONTROL SYSTEMS (CS)

The relation between the behavior of living creatures and the functioning of **CS** has recently gained wide attention. Wiener implied that all systems, living and mechanical are both information and **CS**. Wiener suggested that the most promising techniques for studying both systems are Information theory and **CS** theory.

Several characteristics of **CS** can be linked to human behavior. **CS** can *"think"* in the sense that they can replace to some extent, human operation. These devices do not have the privilege of freedom in their thinking process and are constrained by the designer to some predetermined function. Adaptive **CS**, which is capable of modifying their functioning in order to archive optimum performance in a varying environment, have recently gained wide attention. These systems are a step closer to the adaptive capability of human behavior.

The human body is, indeed, a very complex and highly perfected adaptive **CS**. Consider, for example, the human actions required to steer an automobile. The driver's object is to keep the automobile traveling in the center of a chosen lane on the road. Changes in the direction of the road are compensated for by the driver turning the steering wheel. The driver’s object is to keep the input (the car's desired position on the road) and the input (the car's desired position on the road) as close to zero as possible.

Fig. 1. Illustrates the block diagram of the **CS** involved in steering an automobile. The error detector in this case is the brain of the driver. This in turn activates the driver's muscles, which control the steering wheel. Power

amplification is provided by the automobile's steering mechanism, which controls the position of the wheels. The feedback element represents the human's sensors (visual and tactile). Of course, this description in very crude, any attempt to construct a mathematical model of the process should somehow account for the adaptability of the human being and the effects of learning, fatigue, motivation, and familiarity with the road.

CS process as that found in physical, biological, and social systems. Many systems control themselves through information feedback, which shows deviations from standards and initiates changes. In other words, systems use some of their energy to feedback information that compares performance with a standards and initiates corrective action.

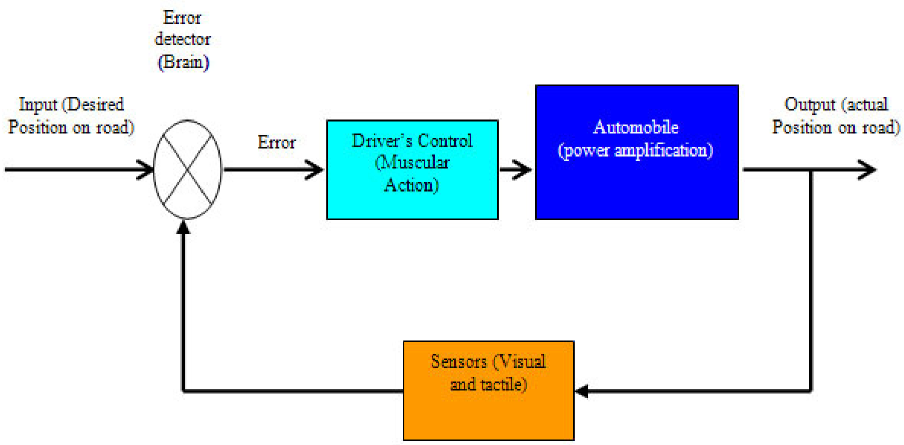

Fig. 1. Steering of an automobile: a feedback control system involving human capability.

The house thermostat is a system of feedback and information control. When the house temperature falls below the preset level, an electric message is sent to the heating system, which is then activated. When the temperature increases and reaches the set level, another message shut off the heater. This continual measurement and turning on and off the heater keeps the house at the desired temperature. A similar process activates the air-conditioning system. As soon as the temperature exceeds the preset level, the air-conditioning system cools the house to the desired temperature. Likewise, in the human body, a number of CS control temperature, blood pressure, motor reactions, and other conditions. Another example of feedback is the grade a student receives on a midterm test. This is intended, of course, to give the student information about how he or she is doing and, if performance is less than desirable, to send a signal suggesting improvement.

3. CONTROL SYSTEMS (CS) IN PHYSICAL SYSTEMS

CS is to be found in almost every aspect of our daily environment. In the home, the refrigerator utilizes a temperature-control system. The desired temperature is set and a thermostat measures the actual temperature and the error. A compressor motor is utilized for power amplification. Other applications of control in the home are the hot-water heater, the central heating system, and the oven, which all work on a similar principle. We also encounter **CS** when driving our automobile. **CS** is used for maintaining constant speed (cruise control), constant temperature (climate control), steering, suspension, engine control, and to control skidding (antiskid system).

In industry, the term automation is very common. Modern industrial plants utilized robots for manufacturing temperature controls, pressure controls, speed controls, position controls, etc. The chemical process control field is an area where automations have played an important role. Here, the CS engineer is interested in controlling temperature, pressure, humidity, thickness, volume, quality, and many other variables. Areas of additional interest include automatic warehousing, inventory control and automation of farming.

In this section, it is presented the state of the CS field by illustrating its application in the following important aspects of engineering: robotics, space travel, commercial rail and air transportation, military systems, surface effect ships, hydrofoils and biomedical CS.

4. CS IN INDUSTRIAL ROBOTS

A new work force strategy without denying the existing of **CS** is established by retooling the work forces, thus the challenges of social impacts could be answers wisely and would be bright opportunities to improve human standards of living.

In manufacturing plants in several countries, there has been a large-scale increase in the usage of **CS** for industrial robots, which are programmable machine tools designed in many cases to accomplish arduous or complex tasks. Although there has been some opposition to the fact that robots often replace human labor, but the trend toward robotics will continue, and on balance, be beneficial to the national economy.

CS developments of the last decade are likely to have as profound a potential impact on productivity, labor markets, working conditions, and the quality of life in the developed countries as the introduction of robot into workplace. The conclusions can be reached based on four factors:

First, the estimate of the number of jobs that could be performed by is relatively small.

Second, almost all of these workers would be spared forced unemployment because of retraining and in some cases the job attrition that occurs through normal retirement.

Third, total employment is a function of real economic growth: robots can have a positive effect on real economic growth and, therefore, a positive effect on total employment.

Fourth, in 10 years, retraining programs can adequately shift displaced workers to new careers. In fact, the main challenge posed to policymakers by increased use of robots is not unemployment but need for retraining.

History shows that labor-saving techniques have led to improved living standards, higher real wages, and employment growth. In large measure, the robotics revolution is merely a continuation of a centuries-long trend that has resulted in enormous material progress. Protection from job loss can come through retraining programs. Working condition and job safety will improve as robots take over dangerous and undesirable forms of works.

Technological advances in computers and microprocessors are increasing the sophistication of robots, giving them some "thinking" capacity that increase potential uses. The key to usage in such area as office work depends in large part on the ability to develop "intelligent" robots capable of performing tasks that vary somewhat over time. Some industry observers believe breakthroughs may allow for extensive introduction of robotics in non-manufacturing tasks within a few years.

Three important dimension of the growth of robotics are subjects to economic analysis:

The first is the determinants of the magnitude of the growth of the robotics industry.

The second is the impact robotics unemployment.

The third is the impact that robots will have on wages, profits and prices.

There are two reasons for the growth in the use of robots, one related primarily to supply and the second primarily to demand. In the long run, robots will be increasingly utilized because the cost of traditional labor-intensive techniques is rising over time, while the cost of the capital-intensive robotic techniques is falling relative to prices generally. These costs decline because the technological advances in robotics lower the capital costs of robots per unit output.

On the other hand, some government policies may speed robotic introduction. For example, where environmental regulations lower worker productivity or raise capital costs associated with the traditional **CS**, the traditional technique cost line will shift upward, advancing the date at which robotic adoption becomes profitable.

Important changes in the composition of the work force have occurred over the past four decades and, in some opinions, even more massive changes lie ahead as many thousands of low-skill jobs are eliminated while at the same time large numbers of new jobs are created to meet the demands of technological advance. If serious employment displacement effects are to be avoided, development of broad-scale training programs in which the private sector plays a key role, in concert with various governmental bodies will be required.

5. CONTROL SYSTEM (CS) THEORY

CS theory is needed for obtaining the desired motion or force needed; sensors for vision and computers for programming these devices to accomplish their desired tasks. Just what is **CS** theory? Who or what is to be controlled and by whom or by what, and why is it to be controlled? In a nutshell, **CS** theory, sometimes called **automation**, **cybernetics** or **systems theory** is a branch of **applied mathematics** that deals with the design of machinery and other engineering systems so that these systems work, and work better than before.

As an example, consider the problem of controlling the temperature in a cold lecture hall. This is a standard engineering problem familiar to us all. The thermal system consists of the furnace as the heating source, and the room thermometer as the record of the temperature of the hall. The external environment we assume fixed and not belonging to the thermodynamic system under analysis. The basic heating source is the furnace, but the control of the furnace is through a thermostat, the thermostat device usually contains a thermometer to measure the current room temperature and a dial on which we set the desired room temperature. The control aspect of thermostat is that it compares the actual and the desired temperatures at each moment and then it sends an electric signal or control command to the furnace to turn the fire intensity up or down. In this case, the job of the **CS** engineer is to invent or design an effective thermostat

Let us next look at a **CS** problem from biology. Parts of the world are being overrun by an increasing population of rats. Here the system consists of the living population of rats and the environmental parameters that affect that population. The natural growth of the rat population is to be controlled to near some desired number, say, and zero. Here the job of the **CS** engineer is to build a better mouse-trap.

From this viewpoint **CS** theory does not appear too sinister. On the other hand, it does not seem too profound. So let us elaborate on the structure of **CS** theory to indicate the reasons why many scientists believe this subject is important. To organize these ideas, it shall be discussed **CS** theory from two viewpoints:

(1) as an intellectual discipline within science and the philosophy of science,

(2) as a part of engineering, with industrial applications and as a force in the world related to social problems of the present and the future.

5.1 CS theory is a Teleological Science

First consider the philosophical position of the discipline of **CS** theory. Within the framework of metaphysics, **CS** theory is a teleological science. That is, the concepts of **CS** involve ideas such as purpose, goal-seeking and ideal or desirable norms. These are terms of nineteenth century biology and psychology, terms of evolution will and motivation such as were introduced by Aristotle to explain the foundations of physics, but then carefully exorcized by Newton when he constructed a human geometric mechanics. So CS theory represents a synthesis of the philosophies of Aristotle and Newton showing that inanimate deterministic mechanisms can function as purposeful self-regulating organisms. Recall how the inanimate thermostat regulates the room temperature towards the agreed ideal.

5.2 CS is an Information Science

Another philosophical aspect of **CS** theory is that it avoids the concepts of energy but, instead, deals with the phenomenon of information in physical systems. If we compare the furnace with the thermostat we note a great disparity of size and weight. The powerful furnace supplies quantities of energy: a concept of classical physics. Thus **CS** theory rests on a new category of physical reality, namely information, which is distinct from energy or matter. Possibly, this affords a new approach to the conundrum of mind versus matter, concerning which the philosophical remarked,

"What is matter? - Never mind
What is mind? - No matter"

But what are the problems, methods and results of **CS** theory as they are interpreted in modern mathematical physics or engineering? In this sense **CS** theory deals with the inverse problem of dynamical systems. That is, suppose we have a dynamical system, for example many vibrating masses interconnected by elastic springs. Such a dynamical system is described mathematically by an array of ordinary differential equations that predict the evolution of the vibrations according to Newton's laws of motion.

5.3 CS in Nature and in Humanity

CS can distinguish between open-loop and closed-loop **CS** and it is a concept or principle that seems to fundamental in nature and not necessarily peculiar to engineering. In human social and political organizations, for example, a leader remains the leader only as long as she is successful in realizing the desires of the group. If she fails, another is elected or by other means obtains the effective support of the group. The system output in this case is the success of the group in realizing its desires. The actual success is measured against the desired success, and if the two are not closely aligned, that is, if the error is not small, steps are taken to ensure that the error becomes small. In this case, control may be accomplished by deposing the leader. Individuals act in much the same way. If our study habits do not produce the desired understanding and grades, we change our study habits so that actual result becomes the desired result.

Because **CS** is so evident in both nature and humanity, it is impossible to determine when **CS** was first intentionally used. Newton, Gould, and Kaiser' cite the use of feedback in water clocks built by the Arabs as early as the beginning of the Christian era, but their next references is not dated until 1750. In the year Markle invented a device for automatically steering windmill into the wind, and this was followed in 1788 by Watt's invention of the fly-ball governor for regulation of the steam engine.

5.4 Development of CS theory

However, these isolated inventions cannot be construed as reflecting the application of any **CS** theory. There simply was not theory although at roughly the same time as Watt was perfecting the fly-ball governor both La Place and Fourier were developing the two transform methods that are now so important in electrical engineering and in **CS** theory in particular. The final mathematical background was laid by Cauchy, with his theory of the complex variable. It is unfortunate that the readers of this text cannot be expected to have completed a course in complex variables, although some may be taking this course at present. It is expected, however, that the reader is versed in the use of the La Place transform. Note the word use. Present practice is to begin the use of La Place transform methods early in the engineering curriculum so that, by the senior year, the student is able to use the La Place transform in solving linear, ordinary differential equation with constant coefficients. But no until complex variables are mastered does a student actually appreciate how and why the La Place transform is so effective. In this text we assume that the reader does not have any knowledge of complex variables but does have a working knowledge of La Place transform methods. Although the La Place transform is the mathematical language of the **CS** engineer, in using this book the reader will not find it necessary to use more transform theory.

Although the mathematical background for **CS** engineering was laid by Cauchy (1789-1857), it was not until about 75 years after his death that an actual **CS** theory began to evolve. Important early papers were "Regeneration Theory," by Nyquist, 1932, and "Theory of Servomechanisms," by Haze, 1934. World War II produced an ever-increasing need for working **CS** and thus did much to stimulate the development of a cohesive **CS** theory. Following the war a large number of linear **CS** theory books began to appear, although the theory was not yet complete. As recently as 1958 the author of a widely used control text stated in his preface that "**CS** are designed by trial and error."

In the early 1960s a new **CS** design method referred to as modern **CS** theory appeared.

This theory is highly mathematical in nature and almost completely oriented to the time domain. Elementary conventional linear system and subsystem modeling (again using computer tools) and approaches to loop design: a comparison of traditional and "intelligent" techniques; notions of self-tuning and adaptive controllers.

5.5 Establishment of Standards

Because plans are the yardsticks against which managers devise controls, the first step in the **CS** process logically would be to establish plans. However, since plans very in detail and complexity, and since managers cannot usually watch everything, special standards are established. Standards are, by definition, simply criteria of performance. They are selected points in an entire planning program at which measure of performance are made so that managers can receive signals about how things are going and thus do not have to watch every step in the execution of plans.

There are many kinds of standards. Among the best are verifiable goals or objectives, as suggested in the discussion of managing by objectives.

5.6 Measurement of Performance

Although such measurement is not always practicable, the measurement of performance against standards should ideally be done on a forward-looking basis so that deviations may be detected in advance of their occurrence and avoided by appropriate actions. The alert, forward-looking manager can sometimes predict probable departures form standards. In the absence of such ability, however, deviations should be disclosed as early as possible.

If standards are appropriately drawn and if means are available for determining exactly what subordinates are doing, appraisal of actual or expected performance is fairly easy. But there are many activities for which it is difficult to develop accurate standards, and there are many activities that are hard to measure. It may be quite simple to establish labor-hour standards for the production of a mass-produced item, and it may be equally simple to measure performance against these standards, but if the item is customs-made, the appraisal of performance may be a formidable task because standards are difficult to set.

5.7 Correction of Deviations

Standards should reflect the various positions in an organization structure. If performance is measured accordingly, it is easier to correct deviations. Managers know exactly where, in the assignment of individual or group duties, the corrective measure must be applied.

Correction of deviations is the point at which control can be seen as a part of the whole system of management and can be related to the other managerial functions. Managers may correct deviations by redrawing their plans or by modifying their goals. This is an exercise of the principle of navigational change or they may correct deviations by exercising their organizing function through reassignment or clarification of duties. They may correct, also, by that ultimate re-staffing measure-firing or, again, they may correct through better leading-fuller explanation of the job or more effective leadership techniques.

6. SUMMARY

CS is to be found in almost every aspect of our daily environment. The human body is, indeed, a very complex and highly perfected adaptive **CS**. Consider, for example, the human actions required to steer an automobile.**CS** is highly multidisciplinary, with issues and features that are distinct from those of other branches of engineering. These issues are numerous and subtle, and often the most important aspects depend on the seemingly most insignificant details. Historically, the subject has advanced by employing abstraction to extract principles that are potentially applicable to a broad range of applications. Unfortunately, this abstraction often obscures the practical ramifications of important ideas. A more concrete approach to the subject an rejuvenate and reinvigorate education in this exciting and important area of technology. Wiener suggested that the most promising techniques for studying both systems are information theory and **CS** theory.

CS process as that found in physical, biological, and social systems. Likewise, in the human body, a number of **CS** control temperature, blood pressure, motor reactions, and other conditions. The human body is, indeed, a very complex and highly perfected adaptive **CS**. Consider, for example, the human actions required to steer an automobile.

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The alert, forward-looking manager can sometimes predict probable departures form standards. In the absence of such ability, however, deviations should be disclosed as early as possible. Standards should reflect the various positions in an organization structure. If performance is measured accordingly, it is easier to correct deviations. Managers know exactly where, in the assignment of individual or group duties, the corrective measure must be applied. Correction of deviations is the point at which control can be seen as a part of the whole system of management and can be related to the other managerial functions. Managers may correct deviations by redrawing their plans or by modifying their goals.

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